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The Stepwise Pricing Mechanism Research of Residents' Living Power

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Abstract

Pricing mechanism is the core of power reform. The NDRC proposed to execute SPM for the living power in October 2010, which met widespread criticisms. An effective SPT is a reasonable, transparent, and stable mechanism, which should impel residents to utilize electricity reasonably, have fully taken economic ability into consideration, and comply with the increasing living standards. To the imperfections of guiding SPM, this paper put forward a SPM, which divides the grads based on the resident living standards, uses the price cap as the early grad pricing method, and regards the improvement of electricity use efficiency as the purpose.

Keywords: Power Reform; Residents Living Power; Stepwise Power Tariff; Pricing Mechanism

1. Introduction

Since 1980s, as the trend of reforming monopoly industry deregulation, global electricity industry actively introduce the competitive system，which has become the direction of power reform. Pricing mechanism is the core of market economy, so constructing an effective mechanism is the core of reform. Theoretically, electricity pricing under government regulation have three methods, namely the maximum profit pricing method, the marginal cost pricing method and the average cost pricing method. In practice, many countries separate power market into power generation, transmission, distribution and sale, different parts with different pricing mechanism [1,2,3].

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In the sale market, living power consumption although smaller than manufacture，its total usage is huge [4,5,6]. Retail market pricing mechanism mainly contains Capacity Price System(CPS), Double Parts Electrovalence System(DPES), Peak-load Electrovalence System(PES), and Consumption Price System(CPS) [1]. Most have been experimented in China [6,7,8].CPS and DPES encourage power plant to supply effectively, which are fit for generation market. PES is aimed at smooth load and improves equipment's usage, which can't incentive power save.

CPS is divided into ungraded and graded consumption price system, which composed by decreasing and increasing patterns. The ungraded consumption price system can't take back the cost from the low consumption residents. The decreasing system aims at realizing scale economy, while the increasing system aims at promoting power saving, taking the low- income residents into consideration. To Chinese power supply and demand condition, the increasing price system is more suitable. The National Development and Reform Commission (NDRC) proposed to execute stepwise pricing mechanism (SPM) for the residents' living power, but the plan encountered many social complains because of its imperfections. This paper analyzes the plan, proposes suggestions to construct a more effective SPM. The second part analyzes the basic assumptions; the third part discusses the principles; the fourth part designs a pricing mechanism and the fifth part is the conclusion.

2. Assumptions on executing SPT for Chinese residents' living power

On October 9, 2010, the NDRC promulgated *Guiding opinions to execute stepwise power tariff (SPT) on residents living power (draft)*. The main idea of the plan is that, according to the average power consumption of residents in different user coverage, the power price is divided into three grades. Using more electricity, the users will be charged a higher stepwise price. In this way, the residents will be encouraged to save electricity. After promulgation, the social has discussed it. Their critical opinions mainly concentrate on three aspects.

Table 1. National average gradient standards of residents' living power stepwise price

	The first grade				The second grade				The third grade	
	User coverage (%)			National average gradient standards (kwh/month)	User coverage (%)			National average gradient standards (kwh/month)	User coverage (%)	National average gradient standards (kwh/month)
	Total	Urban	Rural		Total	Urban	Rural			
1st	70	51	79	110	90	82	95	210	100	More than 210
2nd	80	65	88	140	95	90	98	270	100	More than 270

2.1. The prices and price gradients of different grads

The plan makes the first gradient's price remains stable or rises by 0.01 Yuan, the second by more than 0.05 Yuan, and the third by more than 0.2 Yuan. Pricing rising is inevitable, but the NDRC didn't give a clear explanation. Thus public questions the reform intention—to promote energy conservation, or to increase the price in the name of energy saving?

2.2. The dividing standards and gradients of different grads

Based on coverage rates and average consumption, consumption is divided into three grades, By expanding low-grade electricity price coverage, the original purpose is to reduce reform resistance, but it caused unfair issues. Chinese economy development exist significant regional gaps, so does the power consumption. If the dividing standards base on the country average consumption, the developed regions

would complain the standards too low, while base on separate areas', the developing regions would complain the standards unfair. This would make a bigger gap of residents' living standards and economic development among different areas.

2.3. The plan lacks long-term adaptability.

Along with the rapid economy development and the living standards improvement, power consumption will rise fast, so the dividing standards should be able to adjust dynamically. Averaging user coverage actually encourages using more, because it will make the usage standards higher. This totally deviates from the original intention. If the mechanism can't adjust dynamically, electricity usage and price will be constrained under the current power consumption level. To conquer it, we have to take huge social cost to change the mechanism.

3. The principles of residents' living power price reform

Power reform is to promote social and economic development sustainably. It should both meet the growing demand and inspire them to save power. An effective SPM should be able to dynamically make adaptive adjustments to the continuous improvement of living standards. According to basic requirement of pricing mechanism, living power reform should obey the three principles.

3.1. Combine price stability with incentive effectiveness

Compared with international price, Chinese living electricity prices are slightly low calculated in nominal exchange rate, but they are not low when calculated in monetary PPP or electricity expenses of the proportion of residents' income. On this ground, it is necessary to keep price stable unless income rises by a wide margin. Due to the power demand price elasticity (PDPE) of low-income is small, price rising worsen their living condition. Although middle-income's PDPE is larger, it is not wise to rise by a large margin when the overall income level is not high. So the reform should take into consideration both residents economic ability and PDPE of different income to establish a mechanism.

3.2. Combine static stability with dynamic adjustment efficiently

An effective SPM must be reasonable, transparent and has long-term stability, so that residents can fully understand the price adjustment rules and make a stable anticipation. In recent years, power price has raised many times for equivocal reasons. Because of opacity and instability, the public can hardly predict. Thus every "accidents" raise would trigger a general complain, giving power price adjustment great resistance.

3.3. Combine unified policy with adjustable measures to local conditions

The uneven development of regional economy makes different power consumptions. So an effective mechanism should be unified while giving full consideration to area's differences such as environment conditions, economic level, and the income level, to take account of fairness and efficiency.

4. Stepwise pricing mechanism of residents' living power

4.1. The influencing factors of residents' living power consumption

Demand is mainly affected by price, income, and alternative energy prices. Power price is determined by supply and demand, bargaining power, government regulation, etc. The power consumption is influenced by price changes depending on PDPE. Low-income has a small elasticity; middle-income has the biggest elasticity; while high-income is not sensitive [4]. Normally, the higher income residents consume more power, who own more household appliances quantity, whereas, the power consumption will be less. In addition, alternative energy products supplying capacity and prices play an important role in power consumption. Thus we can construct living power consumption function as follows:

$$Q_e = f\left(p_e, w_a, w_e, p_s, \mu\right) \tag{1}$$

Q_e is the power consumption; p_e is life electricity price; w_a is household appliance quantity; w_e is the unit of household appliances energy consumption; p_s is alternative energy price; μ is the other factors.

4.2. The division of residents' living power price gradient

Based on living standards, we can divide it into Basic Life Type(BLT), Well-Off Life Type(WOLT), Wealthy Life Type(WLT) and Luxury Life Type(LLT). We can use the prevalence rate of large household appliances and energy consumption level, separated as above 85%, 60% ~ 85%, 40% ~ 60% and below 40%, each representing respectively BLT, WOLT, WLT and LLT. Consumption can be estimated separately by the power measurement standard of energy-saving electrical appliances. This can be adjusted along with the improving standards and appliances energy-saving technology, and incent manufacturers to supply more energy-efficient appliances. The consumption in different divisions can be calculated as follows:

$$\begin{aligned} Q_e^m &= \sum_{n=1}^{N} w_e^n \qquad \left(m = 1,2,3,4; n = 1,2,\mathrm{L}\ ,N\right) \\ w_e^n &= \min\left\{w_e^{n1}, w_e^{n2}, \mathrm{L}\ , w_e^{nJ}\right\} \end{aligned} \tag{2}$$

Q_e^m is the consumption of different grades; $m = 1, 2, 3, 4$ respectively represent LLT, WLT, WOLT, BLT; w_e^n is the minimum energy measurement standard of the Nth household appliance, it is determined by the most energy-saving products of the similar functions from No. 1 to No.J, N is the quantity of various types' household appliances that residents own.

4.3. The prices and gradients' of residents living power consumption

BLT for the lowest grade price can be priced by upper-bound method, which can promote effective resource allocation, stable enterprise financial situation and improve operation efficiency. The upper-bound price can be determined as follows:

$$\begin{aligned} p_e^{4t} &= \left[\, p_e^{4(t-1)} \cdot \left(1 + i - X\right)\right] \pm \xi \\ p_e^{4(t0)} &= \left(1 + i' + r\right)^{(t-t0)} \cdot \min\left\{c_1, \mathrm{L}\ , c_k, \mathrm{L}\ c_K\right\} \\ c_k &= \sum p_e^z \cdot \frac{Q_e^z}{Q_e} + g\left(\cdot\right) \qquad \left(z = 1,2,3\right) \end{aligned} \tag{3}$$

p_e^{4t} is upper-bound price for the t year, i is inflation rate, X is the production efficiency compensation factor, ξ is compensation to accident (not including inaccurate calculated costs). $p_e^{4(t0)}$ is the initial price

cap, i' is the annual inflation rate since the initial period, r annual maximum allowable level determined by government regulation department, which has considered the financial rewards, investment risk and tax factors. $\min\{c_1, c_2, \mathrm{L}, c_k\}$ is the lowest average power cost of the power supply enterprises in the initial period; c_k is the addition of weighted electricity purchasing cost of power supply enterprise $p_e^z \cdot Q_e^z / Q_e^{\%}$ and power transmission and distribution costs $g(\cdot)$, z=1,2,3 represent thermal power, water and electricity and other power, p_e^z is the different power prices, $Q_e^z / Q_e^{\%}$ is the proportion of No.Z power purchasing amount Q_e^z out of total power purchasing amount $Q_e^{\%}$.

To WOLT and BLT's price gradient, should be priced according to public energy saving, electricity burden ability and PDPE. The basic principle is to promote them to conserve electricity without affecting living standard. So the gradient formula as follows:

$$\frac{p_e^{3t} - p_e^{4t}}{p_e^{4t}} = \frac{1}{\varepsilon_3} \cdot \frac{Q_e^{3A} - Q_e^m}{Q_e^m}$$
$$Q_e^{3A} = \sum_{n=1}^{N} w_e^{n0} \quad \left(w_e^{n0} = average\left\{ w_e^{n1}, w_e^{n2}, \mathrm{L}, w_e^{nJ} \right\} \right) \tag{4}$$

p_e^{3t} is the permitted price cap of WOLT in t year, ε_3 PDPE of WOLT; w_e^{n0} is the Nth household appliance average energy consumption measurement standard, determined by the most energy-saving products of the similar functions from 1 to J. Q_e^{3A} is WOLT power consumption calculated on w_e^{n0}.

To WLT and LLT's price gradient, the basic principle is to save power and achieve power savings goals in total. So the price gradient can be determined by the formula as follows:

$$\frac{p_e^{mt} - p_e^{(m+1)t}}{p_e^{(m+1)t}} = \frac{1}{\varepsilon_m} \cdot \frac{\max\left\{ Q_e^{mA} - Q_e^m, \Delta Q_e \right\}}{Q_e^m}$$
$$Q_e^{mA} = \sum_{n=1}^{N} w_e^{n0} \quad \left(w_e^{n0} = average\left\{ w_e^{n1}, w_e^{n2}, \mathrm{L}, w_e^{nJ} \right\} \right) \tag{5}$$

p_e^{mt} is the price cap of WLT(m=2) and LLT(m=1) in t year, ε_m is PDPE of WLT and LLT; Q_e^{mA} is wealthy life type and well-off life type power consumption calculated on w_e^{n0}, ΔQ_e is the power saving target, $\max\left\{ Q_e^{mA} - Q_e^m, \Delta Q_e \right\}$ is the larger value between $Q_e^{mA} - Q_e^m$ and ΔQ_e.

4.4. Regulation authority of residents' living power price

To guarantee authority and justice, and adapt to the unbalanced economic development, the price constituting and revising authority should belong to central government, but share with local government. BLT's and WOLT's price regulation should be determined by central while local can adjust ΔQ_e according to the economy development and environmental protection, thus adjust WLT's and LLT's power prices in certain scope. This is good for power price justice and development fair, so does the local profit in energy conservation and emission reduction, finance income.

4.5. conversions between stepwise price and time-of-use electricity price

For electric power industry, its cost function depends on the consumption. Normally, power plant's supply marginal cost in the daytime is bigger than that in midnight. To reflect costs and promote better

usage under the SPM, supply enterprises can use existing time-sharing electricity pricing meters to implement the lowest price in the electricity off-peak period, so as to realize their conversion.

5. Conclusion

Executing SPM for residents living power is beneficial to promote the social electricity saving and is beneficial to improve the comprehensive utilization efficiency. However, at present, the plan lacks scientific whether in theory or in practice, so it has met widespread criticisms. Constructing an effective pricing mechanism is the core of power reform, so the key point of stepwise reform is to construct a reasonable, transparent, stable and long-term mechanism. Basing on the experience abroad and Chinese specific conditions, the writers put forward a SPM which determines the early grade by price cap and regards energy saving as its goal. This SPM has fully taken into consideration the different income residents' economic ability. It can promote reasonable utilization, power saving and make dynamic and effective adjustment to the improving living standards. It can also realize conversion between stepwise price and time-of-use electricity price in the off-peak period. In all, it is a relatively effective pricing mechanism.

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